Table 3.5
Summary Statistic of the Collective Bid by the
Highest Bidder in the Private Market

Experimental Market[a]	Probability of a Loss	N	Collective Bid Less than or Equal to Expected Consumer Surplus $X \leq ES$	Collective Bid Greater Than Expected Consumer Surplus $X > ES$
1. SPCSP	20%	25	14	11
	10%	25	6	19
	1%	25	7	18
	40%	25	14	11
2. CSPSP	20%	21	7	14
	10%	22	2	20
	1%	24	9	15
	40%	25	16	9
3. SICSI	20%	25	12	13
	10%	25	4	21
	1%	25	4	21
	40%	25	14	11
4. CSISI	20%	23	5	18
	10%	24	8	16
	1%	24	3	21
	40%	21	11	10

[a]SPCSP or SICSI - private then collective self-protection or self-insurance
CSPSP or CSISI - collective then private self-protection or self-insurance

The unanimity voting rules were used so the experiments with two mechanisms would be consistent with the one mechanism experiments in Chapter 2. An obvious extension of the two mechanism experiments is to change the voting rules to a majority voting scheme. The highest bidder in the private auction would then have less power to dictate the collective action decision. A preliminary trial experiment indicated that majority voting did induce lower collective bids by the highest bidder. Further experimentation is required to examine this result.

Second, the highest bidder of the private auction may have bid higher than expected consumer surplus for collective action if he or she did not fully understand the experimental instructions. However, this seems unlikely since the phenomena occurred after repeated trials with the monitor emphasizing the highest bidder must pay both the private auction price plus the collective price if collective action is purchased.

Third, the highest bidder may have exhibited altruistic behavior toward other bidders in the collective. Altruism could have been a factor in the low probability of a loss lotteries (10% and 1%) since the additional marginal cost of collective action was generally 5% of wealth for 10% lottery or less than 1% of wealth for the 1% lottery period. The highest private bidder could have viewed his or her collective bid as inconsequential relative to initial wealth.

Finally, the results may indicate that private markets in this experimental design do not act as a highly efficient substitutes for collective action. After repeated trials, individuals may learn that on average the reigning price for the collective reduction was significantly lower than the price for private reduction.

3.4.3 Learning and Value Adjustment

Experimental markets with repeated trials generally require several interactions before a stable equilibrium price is achieved. The rate at which stability is attained is of interest to valuing reductions in risk in that there is a tradeoff in adding additional trials for increased accuracy while simultaneously increasing the respondent's subjective costs of participating in the experiment. This is especially true for field experimentation with the contingent valuation method where most of the respondents are engaged in some other activity, e.g., recreation.

The learning and value formation in experimental markets with two risk reduction mechanisms was mixed. Generally, one would expect ex ante that if any learning occurred over the repeated trials the initial inexperienced hypothetical bid (UEHB) should significantly differ from the final experienced hypothetical bid (EHB). However, in only 44% of the markets and lottery periods did the UEHB did differ significantly from the final EHB bid. In contrast, in the markets with one risk reduction mechanism [Chapter 2], 88% of the UEHB bids differed significantly from the EHB bids. Table 3.6 presents the summary

Table 3.6
Summary Statistic of the Wilcoxon Matched-Sample Sign Test Between Inexperienced (UEHB) and Experienced (EHB) Hypothetical Bids

Experimental Markets with Two Risk Reduction Mechanism[a]	Probability of a Loss	Test Statistic	Observed Significance Level	Experimental Markets with One Risk Reduction Mechanism[b]	Probability of a Loss	Test Statistic	Observed Significance Level
SPCSP	20%	-2.843**	.00	SP	20%	-0.900	.37
	10%	-2.785**	.01		10%	-2.287*	.02
	1%	-3.254**	.00		1%	-3.111**	.00
	40%	-0.765	.44		40%	-0.659	.51
CSPSP	20%	-2.543**	.01	SI	20%	-3.730**	.00
	10%	-2.642**	.00		10%	-3.945**	.00
	1%	-1.900	.06		1%	-3.772**	.00
	40%	-1.320	.19		40%	-3.038**	.00
SICSI	20%	-0.445	.66	CSP	20%	-4.360**	.00
	10%	-0.125	.90		10%	-4.444**	.00
	1%	-0.524	.60		1%	-4.076**	.00
	40%	-1.590	.11		40%	-2.550**	.01
CSISI	20%	-1.009	.31	CSI	20%	-3.712**	.00
	10%	-2.248*	.02		10%	-4.474**	.00
	1%	-2.578**	.01		1%	-4.373**	.00
	40%	-1.549	.12		40%	-3.014**	.00

[a]SPCSP or SICSI - private then collective self-protection or self-insurance
CSPSP or CSISI - collective then private self-protection or self-insurance
[b]SP - private self-protection
SI - private self-insurance
CSP - collective self-protection
CSI - collective self-insurance
*Significant at the .05 level for the null hypotheses of equal central tendencies.

**Significant at the .01 level.

statistic of the Wilcoxon matched-sample sign test comparing UEHB and EHB for each market over each lottery period. The nature of the substitutable private and collective risk reduction mechanisms did not induce a similar pattern of bid adjustment. This result holds even in an identical environment of immediate feedback of the reigning reduction price and the outcome of the lottery for the trial in question.

If one compares the UEHB bid and the EHB bid with the average of the nonhypothetical private (TRA) or collective (TRB) bids for evidence of learning the results are again mixed. The private TRA bid and the collective TRB bid differs significantly from the UEHB bid in 50% and 69% of the cases, respectively. However, the private TRA bid only differs from the EHB bid 6% of the time, while the collective TRB bid differs 50% of the time. The implication is that if value adjustment is occurring, the private risk reduction mechanism appears to be the focus of the final experienced EHB bid. Table 3.7 presents the results of the Wilcoxon matched-sample sign rank test for UEHB, TRA, TRB, and EHB bids.

The value formation results provide mixed support for the use of a second-chance bid in field contingent valuation experiments. Recall, the second-chance bid was designed to elicit an initial bid, provide the respondent with additional market information (e.g., mean bid of other respondents, total annual expenditures on the good), and then ask if he would like to adjust his bid given the new information. The results

Table 3.7
Summary Statistic of the Wilcoxon Matched-Sample Sign Test
Between Inexperienced and Experienced Hypothetical Bids (UEHB and EHB)
and Average Private and Collective Nonhypothetical Bids (TRA and TRb)

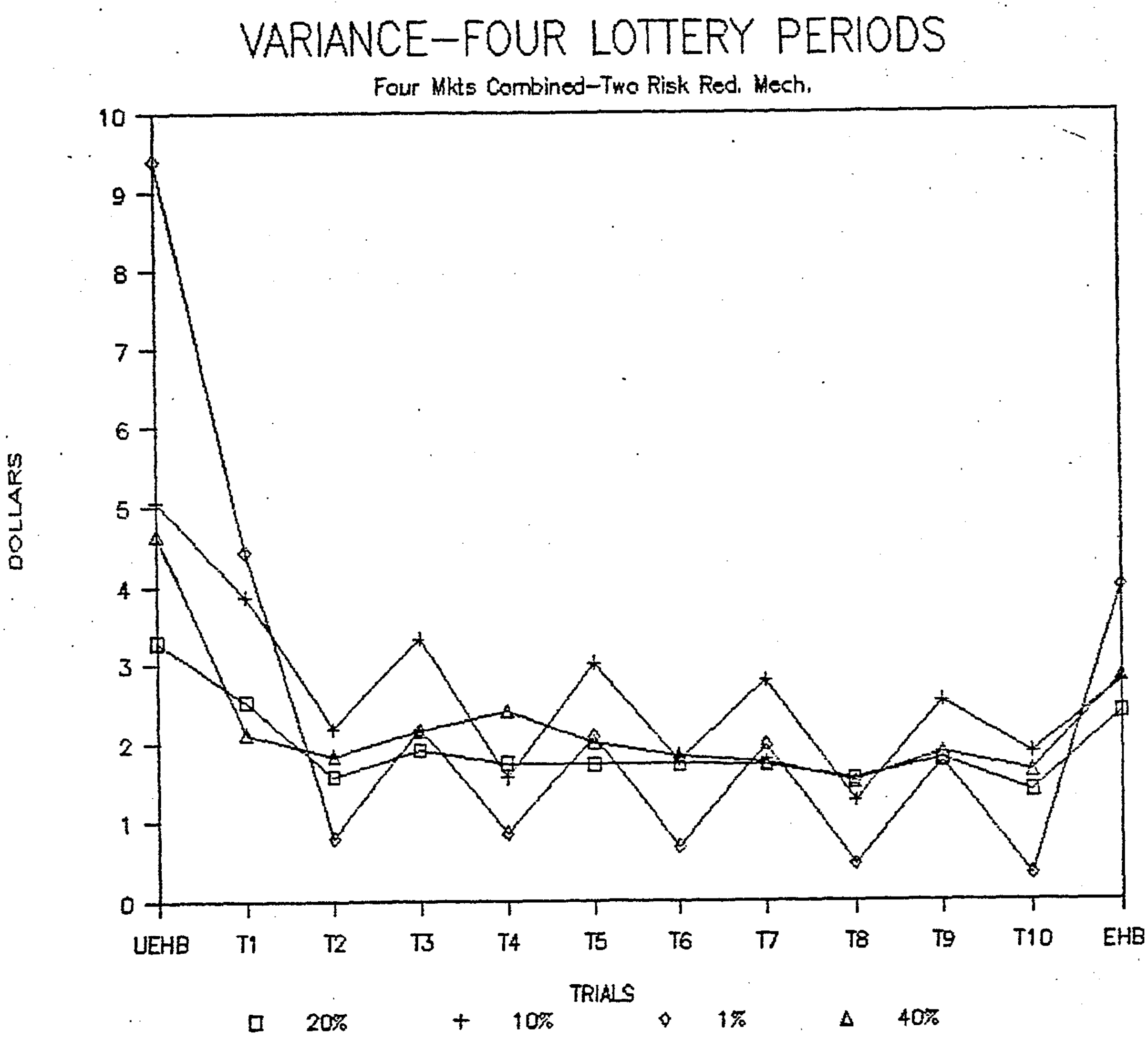
Probability of a Loss	Experimental Market[a]	UEHB/TRA Z[b]	UEHB/TRA p[c]	TRA/EHB Z	TRA/EHB p	UEHB/TRB Z	UEHB/TRB p	TRB/EHB Z	TRB/EHB p
20%	SPCSP	-2.00*	.05	-0.79	.43	-3.35**	.00	-2.15*	.03
	CSPSP	-2.78**	.01	-0.51	.61	-2.67**	.01	-0.10	.92
	SICSI	-0.92	.36	-0.47	.64	-2.26*	.02	-3.07**	.00
	CSISI	-1.14	.25	-0.29	.77	-1.64	.10	-0.88	.38
10%	SPCSP	-2.27*	.02	-1.41	.16	-3.17**	.00	-1.32	.19
	CSPSP	-2.64**	.01	-0.20	.84	-1.80	.07	-2.53**	.01
	SICSI	-0.77	.44	-0.17	.86	-2.53**	.01	-3.83**	.00
	CSISI	-1.87	.06	-0.41	.68	-3.46**	.00	-1.23	.22
1%	SPCSP	-2.29*	.02	-2.27*	.02	-2.48**	.00	-0.46	.65
	CSPSP	-2.26*	.02	-0.03	.98	-1.89	.06	-1.28	.20
	SICSI	-0.55	.58	-1.03	.30	-1.26	.21	-2.38*	.02
	CSISI	-2.74**	.01	-1.79	.07	-2.71**	.01	-1.84	.07
40%	SPCSP	-0.48	.63	-0.34	.74	-2.19*	.03	-3.21**	.00
	CSPSP	-1.39	.17	-0.61	.54	-1.55	.12	-0.32	.75
	SICSI	-2.08*	.04	-0.55	.59	-3.36**	.00	-2.48**	.01
	CSICI	-1.82	.07	-0.98	.33	-2.40*	.02	-2.07*	.04

[a]SPCSP Private then collective self-protection, CSPSPS - collective then private self-protection, SICSI - Private then Collective Self-insurance, and CSISI - collective then private self-insurance
[b]test Statistic
[c]observed significance level
*Significant at the 5% level
**Significant at the 1% level

obtained in the experimental markets with two risk reduction mechanisms indicate that one additional trial might not be sufficient to induce stable value formation. The additional realism of substitutable markets requires more trials and may increase the subjective costs of participating (e.g., lost time) to a prohibitive level. Experimentation of the second chance bid in a field context under both markets with one or two risk reduction mechanisms would provide a useful test of robustness. Note, however, that will the additional trials were not wholly successful at inducing a stable bid, the variance between bids decreased to a relatively stable level. Figures 3.7, 3.8, and 3.9 illustrate the variance over all four lottery periods combined, and a 1% and 20% probability of a loss.

Finally, to test if the inexperienced hypothetical bid (UEHB) is a statistically significant predictor of the final experience bid (EHB), we estimated a separate ordinary least squares model for each experimental market for the four lottery periods. Table 3.8 summarizes the results of the models. For the 20% and 10% lottery period at least three of the four markets yielded statistically significant regression coefficients (.01% level).

As in Chapter 2, however, the 1% lottery period had mixed results at predicting the experienced bid. Only one market (SPCSP) was a significance predictor of experienced bid at the .01 level, and one market (CSISI) was significant at the .05 level. Again this result is unencouraging for predicting



VARIANCE-FOUR LOTTERY PERIODS
Four Mkts Combined-Two Risk Red. Mech.
DOLLARS
0
1
2
3
4
5
6
7
8
9
10
UEHB
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
EHB
TRIALS
20%
10%
1%
40%

Figure 3.7

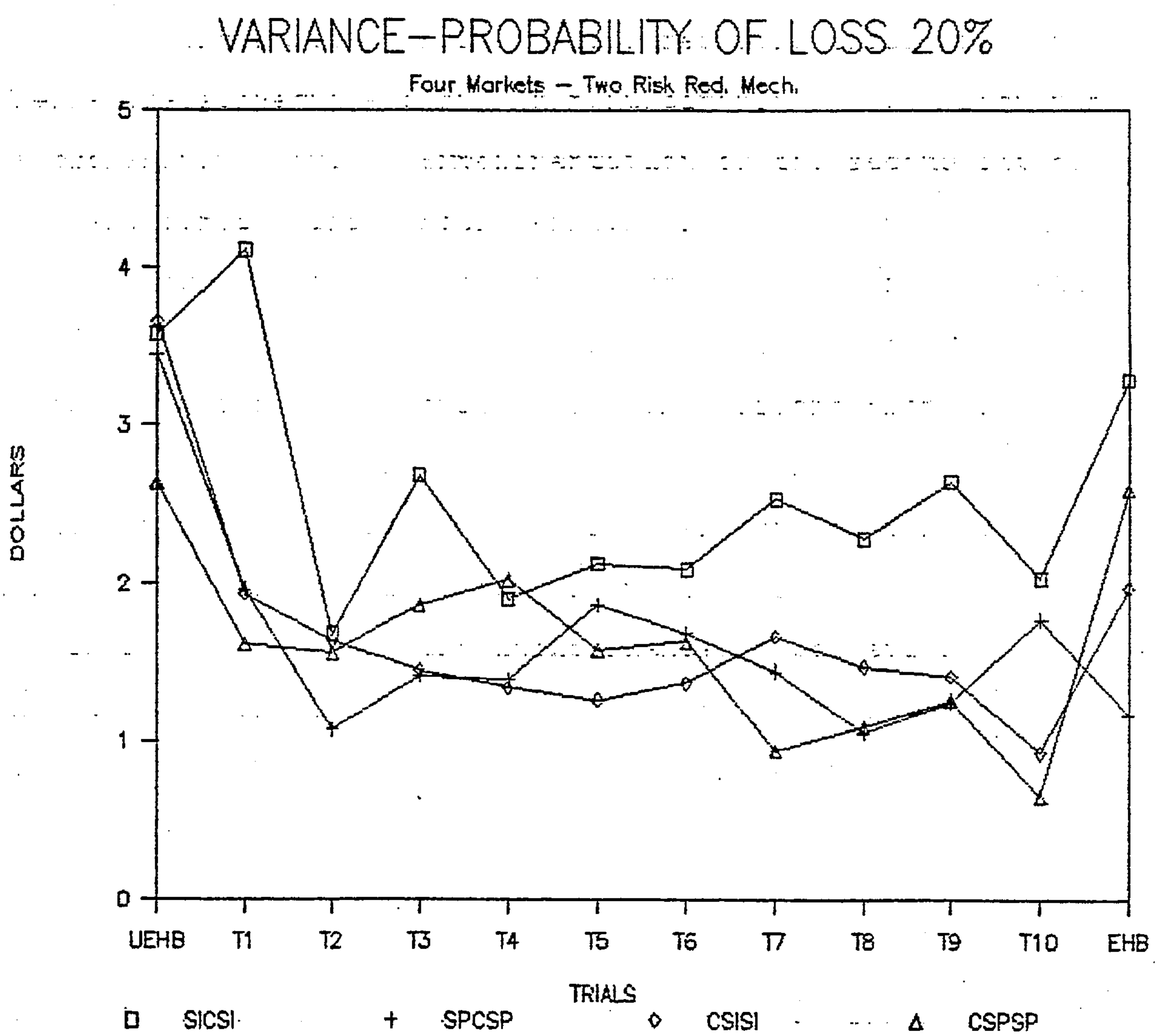

VARIANCE-PROBABILITY OF LOSS 20%
Four Markets - Two Risk Red. Mech.
DOLLARS
0
1
2
3
4
5
UEHB
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
EHB
TRIALS
SICSI
SPCSP
CSISI
CSPSP

Figure 3.8

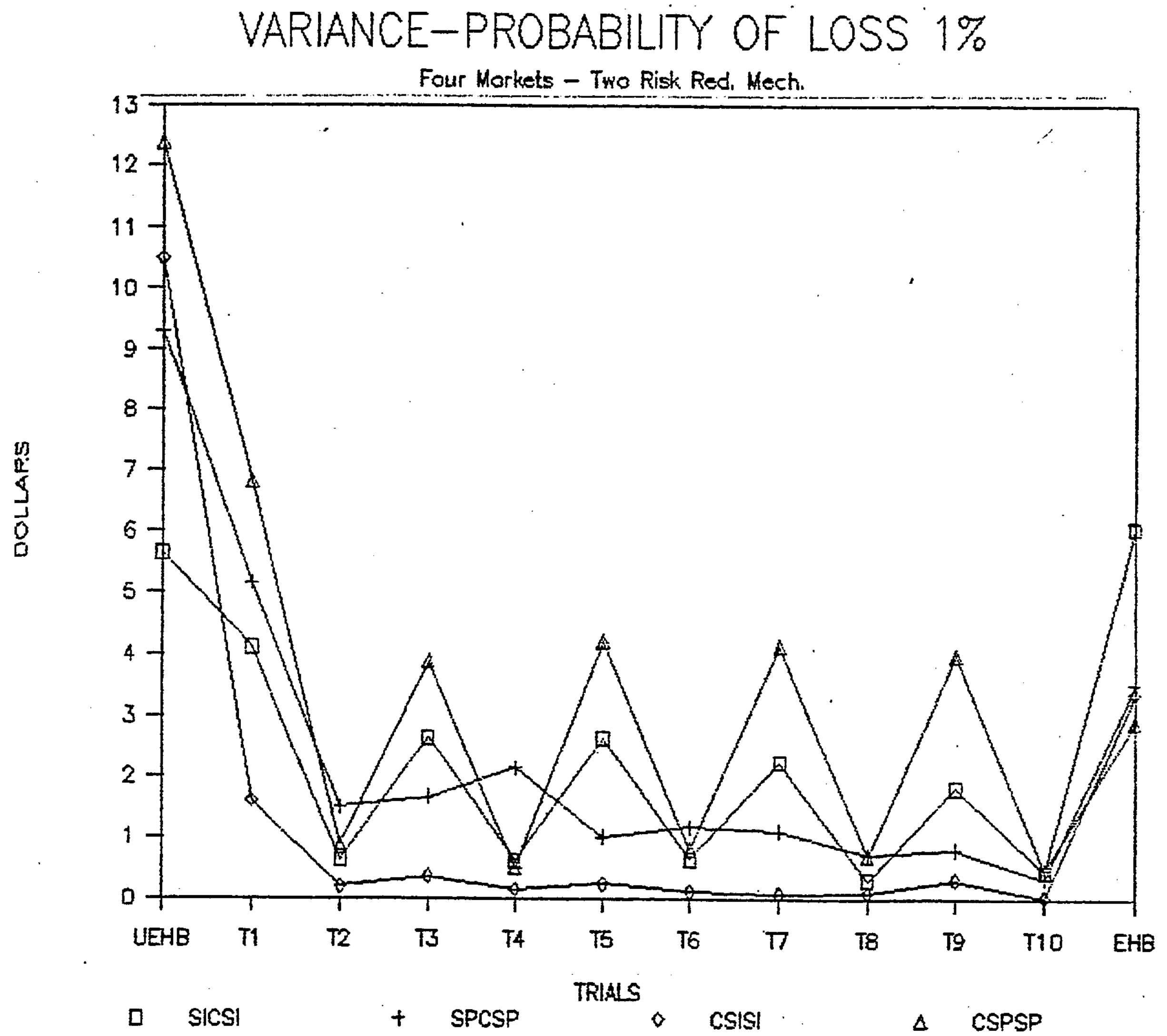

VARIANCE-PROBABILITY OF LOSS 1%
Four Markets - Two Risk Red. Mech.
DOLLARS
13
12
11
10
9
8
7
6
5
4
3
2
1
0
UEHB
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
EHB
TRIALS
SICSI
SPCSP
CSISI
CSPSP

Figure 3.9

Table 3.8
Summary Results for Ordinary Least Squares
Model of Experienced Hypothetical Bids for
Markets with Two Risk Reduction Mechanisms

Probability of a Loss	Experimental Market[a]	Constant[b]	Inexperienced Hypothetical Bid	R^2
1. 20%	SPCSP	0.683*	0.388**	.44
		(2.691)	(4.723)	
	CSPSP	0.033	0.742**	.56
		(0.092)	(5.969)	
	SICSI	1.170*	0.558**	.34
		(2.377)	(3.784)	
	CSISI	1.278**	0.263*	.13
		(3.241)	(2.033)	
2. 10%	SPCSP	0.436	0.377	.41
		(1.566)	(4.431)**	
	CSPSP	0.518	0.354**	.28
		(1.479)	(3.281)	
	SICSI	0.861	0.606**	.29
		(1.664)	(3.369)	
	CSISI	0.837**	0.081	.03
		(2.868)	(0.890)	
3. 1%	SPCSP	-0.065	0.433**	.50
		(-.218)	(5.247)	
	CSPSP	0.950*	0.056	.01
		(2.438)	(0.615)	
	SICSI	1.080*	0.259	.06
		(2.080)	(1.367)	
	CSISI	0.265	0.211*	.14
		(0.746)	(2.125)	
4. 40%	SPCSP	2.009**	0.214	.13
		(5.225)	(2.060)	
	CSPSP	1.377*	0.243	.04
		(2.135)	(1.099)	
	SICSI	1.896**	0.343**	.28
		(4.262)	(3.336)	
	CSISI	1.703**	0.276*	.12
		(3.117)	(1.995)	

[a]The market definitions are: SPCSP = private then collective self-protection, CSPSP = collective then private self-protection, SICSI = private then collective self-insurance, and CSISI = collective then private self-insurance.
[b]Numbers in parentheses are the ratio of the estimated coefficients to their standard errors.
*Significant at the .05 level using a one-tailed test for the null hypothesis that the population mean is zero.
**Significant at the .01 level using a one-tailed test.

experienced market valuations since most naturally-occurring risks are less than 1%.

3.4.4 Self-Protection vs. Self-Insurance

Finally, we consider the differences, if any, between self-protection and self-insurance in experimental markets with both private and collective risk reduction mechanisms. In contrast to the experiments with one mechanism discussed in Chapter 2, there is no evidence to support a significant difference between bids for probability-influencing self-protection and severity-influencing self-insurance. Table 3.9 presents the results of the Wilcoxon matched-sample sign tests comparing the bids between markets SPCSP and SICSI and between markets CSPSP and CSISI. The inexperienced and experienced hypothetical bids (UEHB and EHB), and the nonhypothetical private and collective bids averaged over the five trial periods (TRA and TRB) were examined.

In 100% of the cases, the UEHB bid was insignificantly different between self-protection and self-insurance. This is not surprising since if a difference exists it should be exaggerated as trials repeat and learning occurs. However, only in 15% of the EHB bids was there a significant difference between self-protection and self-insurance. In contrast, experimental markets with one mechanism induce nearly 100% significant differences in EHB bids.

In addition, when comparing TRA and TRB bids across self-protection and self-insurance markets, we find only 7.5% of both

Table 3.9
Summary Statistic of the Wilcoxon Matched-Sample Sign Test
for Comparison of Self-Protection and Self-Insurance

Experimental Markets[a]	Probability of a Loss	UEHB[b]		TRA		TRB		EHB	
		Z[b]	p[c]	Z	p	Z	P	Z	P
SPCSP and SICSI	20%	0.69	.49	1.66	.10	1.94	.05	2.32*	.02
	10%	-0.15	.88	0.33	.74	-0.15	.88	1.09	.28
	1%	0.11	.91	0.49	.63	0.73	.46	1.55	.12
	40%	1.52	.13	0.99	.32	0.63	.53	1.44	.15
CSPSP and CSISI	20%	0.54	.59	-0.04	.97	1.78	.08	0.76	.45
	10%	-1.24	.22	-2.61**	.01	-0.92	.36	-0.27	.78
	1%	-1.29	.20	-1.43	.15	-0.82	.41	-1.00	.32
	40%	1.32	.19	1.61	.11	0.83	.41	2.14*	.03

[a]SPCSP and SICSI - private then collective self-protection or self-insurance
CSPSP and CSICSI - Collective then private self-protection or self-insurance.
[b]UEHB and EHB - inexperienced and experienced hypothetical bid (mean)
TRA and TRB -average private and collective nonhypothetical bid (mean)
[c]Test statistic
[d]Observed significance level
*Significant at 5% level
**Significant at 1% level

the TRA bids and TRB bids differed significantly, Consequently, our evidence does not support our earlier findings of a significant difference. In the next chapter we extend the examination of behavioral outcomes regarding probability versus severity to a bargaining framework. The evidence from the bargaining experiments support the results in this chapter--no behavioral difference in individual outcomes over probability relative to severity of a risk.

3.5 Summary and Conclusions

Although the ability to act independently on one's own behalf is a prominent feature of many, perhaps most, environmental and health and safety issues, its relevance to the determination of option value has not heretofore been explored. A recognition of its relevance simply expands the number of circumstances in which the sign of option value, as traditionally defined, can be shown to be ambiguous. If various reasonable interdependencies (e.g., technical complimentarities, price interactions) were introduced along with endogenous risks into the analysis, the list of cases with ambiguous signs would undoubtedly expand. Even the case of the sure provision of the desirable state, which the literature has predicted to possess a positive option value, is easily shown to be unsignable when self-protection is available. A complete measure of ex ante value, therefore, must include both self-protection and option price expenditures.

Endnotes

*The theory section of the chapter was written with Thomas D. Crocker in a manuscript entitled "Self-Protection, Option Price, and Option Value."

1. See Anderson (1979), Graham (1981), and Helms (1985) for recent formal treatments of this definition.

2. Among others, Schmalensee (1972), Chavas, et al. (1986), Plummer and Hartman (1986), and Cory and Saliba (1987) have considered the sign of option value under conditions of demand uncertainty; Bishop (1982) and Brookshire, et al, (1983) have evaluated it when supply uncertainty prevails; and Graham-Tomasi (1985) investigated it in an explicit intertemporal context.

3. One should not confuse endogenous supply uncertainty with quasi-option value. The latter concept, as set forth in Arrow and Fisher (1974), Bernanke (1983), Miller and Lad (1984), and elsewhere focuses upon the timing of choices relative to the timing of information acquisition in order to ascertain whether the prospect of learning influences the efficiency conditions for irreversible investment decisions. It therefore assumes that new data might sooner or later be somehow introduced into the consumer's decision problem. In contrast, our interest is with the consumer's ability to manipulate intentionally the probabilities or severity of alternative states of nature, not with his opportunities to generate new data such that he can learn more about these states.

4. By assuming that demand is state independent, we disregard demand uncertainty. We justify this neglect on the intuitive grounds that the price, money income, and preference ordering sources of demand uncertainty are much less susceptible to immediate and direct consumer manipulation.

5. Conrad (1986) makes a similar point. Our paper differs, however, in that (a) we directly address the impact of self-protection upon the individual's ex ante risk premium (option value); and (b) the individual influences through his option price payment the optional level of collectively-supplied reduction. Conrad's (1986) results nevertheless support our view that accurate ex ante benefit estimation requires attention to both self-protecting expenditures and collective option price payments.

6. Gallagher and Smith (1985) and Smith (1985) refer to changes in probabilities in combination with individual adjustment opportunities, but they do not treat self-induced changes in the probabilities of alternative states as an adjustment opportunity. The adjustments to which they refer appear to involve only the redistribution of income toward desirable states rather than endogenous manipulations of the probabilities of these states.

7. Given that option price is defined in terms of an expected compensating variation, this binary assumption, which is standard in the option value literature, avoids the integrability problems raised by Chipman and Moore (1980) with respect to possible inconsistencies in using compensating measures to rank more than

two alternatives.

8. In the absence of strategic preference revelations, the individual's option price and his option payment would be identical. An implicit assumption of nonstrategic behavior pervades the option value literature.

9. Weinstein et al. (1980) discuss ex ante preventive expenditures in terms of public provision of preventive health practices relative to ex post curative expenditures. However, they do not account for substitution possibilities. The empirical literature estimates maximum option payments by framing the payment mechanism in terms of government action as the only possible way to finance increased probability of provision [see Greenley et al. (1981), Brookshire et al. (1983), Walsh et al. (1984), Smith and Desvousges (1986a)(1987)]. No framework for incorporating self protection or substitute activities is evident in these analyses.

10. The term "moral hazard" has been coined for questions involving the effect of market and self-insurance upon the demand for self-protection [Arrow (1963)]. Our interest is in the effect of self-protection upon the demand for insurance.

11. Goddeeris (1983) briefly introduces endogenous probability in the context of mitigating differing intensities of risk [p. 157]. However, he never uses an endogenous framework to reformulate the option value argument.

CHAPTER 4

Coasian Bargaining over Ex Ante Lotteries and Ex Post Rewards

4.1 Introduction

Coase (1960) envisioned a world in which two self-interested parties will bargain to a mutually advantageous, Pareto-optimal level of an externality regardless of initial unilateral property right entitlements. The power of Coase's world rests in the decentralized attainment of efficient resource allocation even in the presence of market failure. The potential policy implications of the so-called Coase theorem are enormous. If the Coase theorem is robust, then the role of a third party (e.g., the state) is reduced to simply assigning unambiguous unilateral property rights which facilitate private bargaining and economic efficiency.

Beginning with Prudencio (1982) and Hoffman and Spitzer (1982), several experimental studies have demonstrated the Coase theorem is quite robust.[1] In general, the studies have supported the two key behavioral outcomes implied by Coasian bargaining: (i) two parties will agree on a Pareto-optimal level of an externality, and (ii) the agreement will be obtained through mutually advantageous bargaining between two parties. As Harrison et al, (1987) note the Coase theorem is "behaviorally 'alive and well' in relatively sterile and abstract bargaining environments."

The experimental studies have been reluctant however, in proposing policies for the naturally occurring environment. A major reason is most monetary payoffs (profits or damages) in the natural environment involve some degree of uncertainty.[2] In contrast, Coase experiments have been designed such that payoffs are known with complete certainty. The two parties bargain over the selection and distribution of a deterministic payoff stream.[3] Consequently, Hoffman and Spitzer (1985b) and Harrison et al. (1987) warn against overextending the robust experimental results to environments where payoffs are uncertain.[4]

The purpose of this chapter is twofold. First, we examine the robustness of Coasian bargaining under uncertainty. The experiment examines both simple and compound binary lottery games. A simple binary lottery game is a one-stage lottery where the winner of a deterministic monetary reward is uncertain. A compound binary lottery game is a two-stage lottery where both the winner and the amount of the reward is uncertain. The experiments examine both lottery games for the two conditions necessary for the existence of Coasian bargaining: Pareto-optimal and mutually exclusive agreements.

Second, we step beyond Coasian bargaining and explore a fundamental issue in choice under uncertainty. An uncertain event (desirable or undesirable) is comprised of two key components--the probability an event will occur and the magnitude or severity of the event. We consider if individuals react differently when bargaining over the probability (lottery) or the magnitude (reward) of the event. We consider this point because in Chapters 2 evidence suggests a significant difference in behavioral outcomes exists. Namely, subjects reacted significantly different when asked to value a probability-reducing decrease in risk (self-protection) than a severity-reducing decrease in risk (self-insurance).[5] These Coasian bargaining experiments provide an alternative test to determine if a fundamental difference exists or if the difference is an artifact of the risk reduction experiments.

To examine this second issue, two distinct bargaining sessions are designed: (a) ex ante lottery bargaining and (b) ex post reward bargaining. Ex ante lottery bargaining exists when two parties bargain over the distribution of lottery tickets that determine the probability of winning either a certain or an uncertain reward. Ex post reward bargaining exists when two parties bargain over the distribution of the resulting reward. Both bargaining sessions are used in the simple and compound lottery games.

The results of the experiment provide tentative answers to the following questions: (1) Does Coasian bargaining remain Pareto-optimal under uncertainty? Yes, Coasian bargaining remains highly efficient even under uncertain payoff streams. With 86.6 percent of all bargaining agreement achieving the joint maximum payoffs, our evidence provides further support for the weak behavioral form of the Coase Theorem.
(2) Does Coasian bargaining remain mutually advantageous under

uncertainty? No, under uncertainty the bargainers tended to pool risk rather than seek mutually advantageous outcomes. Nearly 84.2 percent of all agreements essentially agreed to pool the risk and split the payoff or chances to win the reward even though this implied a disadvantegous bargain to the controller relative to the expected payoff without a bargain.[6] Consequently, our evidence does not support the strong behavioral form of the Coase Theorem.

(3) Is there a significant behavioral difference in Coasian bargaining over ex ante lotteries and ex post rewards? No, given our sample there was no significant statistical difference in bargaining over ex ante lotteries and ex post rewards. This hold for both behavioral outcomes of Pareto efficiency and equal split of rewards and lottery tickets. This result is supportive of the findings in Chapter 3 were the value of risk reduction given probability-influencing self-protection and severity-influencing self-insurance were not significantly different. The result is, however, in sharp contrast to the individual behavior in Chapter 2. Individuals valued self-protection significantly more than self-insurance. Our Coasian bargain experiments illustrate that a fundamental difference might not exist in individual behavior toward probabilities (lotteries) and severity (outcomes) of uncertain events.

(4) Does increased uncertainty affect the robustness of Coasian bargaining agreements? No, there was no significant statistical difference in bargaining over the simple lottery and the compound

lottery. Again this holds for both behavioral outcomes of Pareto efficiency and the equal splitting of rewards and lottery tickets. Individuals pooled risk similarly for both the simple and compound lottery. Greater uncertainty did not create basic differences in bargaining behavior over probabilities and severity.

The chapter proceeds as follows. Section 4.2 defines the simple and compound binary lottery games. Section 4.3 examines the experimental design and procedures. The results of the experiment are presented in Section 4.4. Finally, the conclusions are presented in Section 4.5.

4.2 Coasian Bargaining and Binary Lottery Games

In general, a Coase experiment must satisfy Hoffman and Spitzer's (1982) well-defined set of assumptions: (a) two parties to each bargain, (b) perfect knowledge of one another's utility functions, (c) perfectly competitive markets, (d) zero transactions costs, (e) costless court system, (f) profit-expected utility-maximizing consumers, (g) no wealth effects, and (h) parties will strike mutually advantageous bargains in the absence of transactions costs. Given assumptions (a) through (g), assumption (h) creates two testable behavior outcomes of Coasian bargaining: (i) Pareto-optimal agreements between two parties and (ii) the agreements are mutually advantageous. We focus on these two outcomes in testing Coasian bargaining under uncertainty.

Given uncertainty, the experiment is designed so that the parties' von Neumann-Morgenstern expected utility function can be determined. Following Roth and Malouf (1979), we determine expected utility by constructing a binary lottery game. A binary lottery game is used to control individual variation due to differences in risk preference in that each party has a given probability of winning either a large reward or a small reward. The parties bargain over how to allocate the chance of winning the large reward or how to distribute the large **reward.**[7] For our experiments both simple and compound binary lottery games are constructed.

First, consider the simple one-stage binary lottery game. There are two parties, A and B, for each bargaining agreement. Each party can win either a large reward R or a small reward r, $R > r$. There is a distribution of lottery tickets which reflect the chances of winning the rewards. Let $L = [pR; (1-p)r]$ be the simple binary lottery such that party A has probability p ($0 \leq p \leq 1$) of winning R and probability (1-p) of winning r. Note $0 < p + (1-p) \leq 1$. The expected utility of party A then is

$$U(L) = pU(R) + (1-p)U(r)$$

As noted by Roth (1987), since information about preferences implied by an expected utility function is explicitly represented only up to an arbitrary choice of scale and origin, there is no loss in generality in normalizing each party's utility such that $U(R) = 1$ and $U(r) = 0$. Therefore, in the ex ante lottery bargaining sessions, party A's expected utility is precisely equal to the probability p of winning the large reward, U(L) = p. Party B's expected utility is then equivalent to B's probability of winning the large reward (1-p).

Roth also notes that the set of utility payoffs to the parties of a binary lottery game is insensitive to the magnitudes of R and r for both parties. The parties have complete information whether they know each others rewards, since knowing a party's probability of winning R is equivalent to knowing his utility. Therefore, Coasian assumption (b), perfect knownledge of utility, holds.

In the ex post bargaining session, two parties bargain over the distribution of the large reward. For example, say party A agrees to receive 40% of the large reward if either party A or B wins.

Let Z the amount of the reward A receives with probability $\overline{p} = p + (1-p)$. Note $r \leq Z \leq R$. Party A's expected utility then is

$$\overline{p}U(Z) = U(L) = p$$

or

$$U(Z) = p/\overline{p}$$

Therefore, if the Pareto-efficient outcome is agreeed on, then $\overline{p} = p + (1-p) = 1$, and Party A's utility from receiving Z is precisely equal to the probability p of receiving the large **reward.**[8] Party B's utility from receiving Z equals (1-p).

Second, consider the compound two-stage binary lottery game. The compound lottery differs from the simple lottery in that the winner of the first-stage lottery is not guaranteed of earning the large reward with 100% certainty. There is a second-stage in which the winner of the first-stage now has probability q of earning the large reward R and probability (1-q) of earning the small reward r.

The compound lottery is used to examine bargain behavior and individual choice under increase uncertainty. As is evidenced by the so-called "Winner's Curse," not all winners of lotteries or auctions are guaranteed a large reward.[9] Often the winner of a lottery will find the realized reward substantially less than expected. The compound lottery captures the increased uncertainty but still allows the party's utility to be determined. Let $\tilde{L} = [p\tilde{R}; (1-p)r]$ be the first-stage of the compound lottery such that party A has a probability p of winning R and probability (1-p) of winning r. Let $\tilde{R} = [qR; (1-q)r\}$ be the second stage of the compound lottery. After the winning party is decided in L, the winner has probability q of winning the large reward and probability (1-q) of winning the small reward. Note q + (1+q) = 1. The expected utility of party A then is

$$U(\tilde{L}) = p[qU(R) + (1-q)U(r)] + (1-p)U(r)$$

Again normalize utility such that U(R) = 1 and U(r) = 0. Therefore, in the ex ante lottery sessions, party A's expected utility is precisely equal to the probability p of winning the lottery times the probability q of winning the large reward, $U(\tilde{L}) = pq$. Party B's expected utility then equals $(1-p)q$.

In the ex post bargain sessions, since both parties agree to receive some Z ($r \leq Z \leq R$) with probability $\tilde{p} = pq + (1-p)q \leq q$, Party **A's** utility is

$$\tilde{p}U(Z) = U(\tilde{L}) = pq$$

or

$$U(Z) = pq/\tilde{p}$$

Again, if a Pareto-efficient agreement is reached, then $\tilde{p} = = pq + (1-p)q = q$, and Party A's utility from receiving Z equals the probability of receiving the large reward p. Party B's utility of receiving Z when $\tilde{p} = q$ is equal to $(1-p)$.

Finally, if two parties cannot come to an agreement in the allotted time, a disagreement reward D is provided to each party. To control for risk preference, the disagreement reward equals the small reward, $D = r$. Therefore, there is no incentive for one risk averse party to hold out for the disagreement prize.

Given the Coasian assumptions (a)-(h) and the binary lottery games, four propositions are presented. The first two propositions consider Coasian bargaining under uncertainty.

<u>Proposition 1 (P1)</u>: Two parties will bargain to a Pareto-optimal lottery schedule under uncertain monetary payoffs.

<u>Proposition 2 (P2)</u>: Two parties will bargain to a mutually advantageous agreement over distribution of lottery tickets or rewards under uncertainty.

Acceptance of P1 and P2 will provide support for robust Coasian bargaining even under uncertainty. If P1 and P2 are not accepted, however, then the general Coase theorem is not universally applicable to bargaining under uncertain monetary payoffs. Since most natural environments involve uncertainty to some degree, nonacceptance will continue to restrict the applicability of Coasian bargaining to policy decisions.

The last two propositions consider the general behavioral outcomes under uncertainty.

<u>Proposition 3 (P3)</u>: There is no behavior difference in Coasian bargaining over ex ante lotteries and ex post rewards.

Acceptance of P3 will not support earlier experimental evidence (Chapter 2) that a significant behavioral difference exists in individual perception over probability versus magnitude of an event. If P3 is not accepted, however, these Coasian bargaining experiments provide further support to the view that a fundamental behavioral difference might indeed exist.

<u>Proposition 4 (P4)</u>: There is no behavioral difference in Coasian bargaining in simple versus compound binary lottery games.

Acceptance of P4 suggests the robustness of Coasian bargaining is independent of the degree of uncertainty. Coasian bargaining in the experiments would have a similar strength or weakness. If P4 is not accepted, then further experimentation is warranted to determine if a boundary exists of robust Coasian bargaining under uncertainty.

4.3 Experimental Design and Procedures

To the extent possible, the experimental design and procedures follow Hoffman and Spitzer (1982) and Harrison and McKee (1985). All subjects were undergraduate students at Appalachian State University, and were considered inexperienced bargainers, i.e., no subject had participated in a Coasian bargaining experiment. As the subjects entered the lab, each was randomly assigned to be either party A or party B.

Each subject was given an identical set of instructions. The subjects were told they would participate in two successive bargaining sessions, each session with a different opponent. Opponents differed to reduce learning behavior and altruism, thereby increasing the incentive for mutually advantageous bargaining. Each bargaining session was face-to-face, public, and had a ten minute time constraint. No physical threats were allowed. A monitor was present for each session. The monetary payoffs were public but only after completion of both sessions.

Subjects participated in either the simple or the compound lottery, not both. Regardless of the lottery game, each subject participated in one ex ante lottery and one ex post reward bargaining session. Each session had an agreement outcome and a disagreement outcome. The agreement outcome required agreement by the two parties on (i) which number to select from a lottery schedule reflecting each party's probability of winning the large reward [see Table 4.1], and (ii) how to distribute lottery tickets which determine the probability of winning a reward (ex

Table 4.1

Alternative Lottery Schedules

Schedule	Number	A's Chance to Win (%)	B's Chance to Win (%)	Joint Chance (%)
X	1	0	80	80
	2	15	75	90
	3	35	65	100
	4	40	55	95
	5	65	25	90
	6	75	20	95
	7	80	0	80
Y	1	0	90	90
	2	15	85	100
	3	30	65	95
	4	50	40	90
	5	75	20	95
	6	80	5	85
	7	90	0	90
Z	1	0	80	80
	2	5	75	80
	3	15	60	75
	4	25	55	80
	5	45	35	80
	6	75	25	100
	7	80	0	80

NOTE: Joint chances to win (%) were not provided to subjects.

ante lottery) or how to distribute the reward (ex post reward). All agreement outcomes required both parties sign a contract stating the number selected and the distribution of lottery tickets or reward. The contracts were perfectly enforced by the monitor.

If two parties could not come to an agreement in the allotted time, then the disagreement outcome was enforced. The disagreement outcome was consistent across bargaining sessions: If two parties could not come to an agreement, both parties would receive the small reward (zero) for that session. The zero payment disagreement outcome controlled for potential risk posturing by the bargainers.

At the start of each session one party, the controller, was given unilateral property rights over the lottery schedule. The controller had complete control over which number was selected from the lottery schedule. The controller could select a number him/herself and inform the monitor, who would then end the session. The other party attempted to influence the controller to reach a mutually advantageous decision by offering to give part or all of his lottery tickets or realized reward to the controller.

Following Hoffman and Spitzer's (1985b), experiments on concepts of distributive justice, the controller was determined on a competitive basis. Hoffman and Spitzer found a competitive game trigger increased the incentive for mutually advantageous bargaining. A simple random assignment of controller privileges (e.g., coin flip) increased the likelihood of equal distribution of payoffs. The goal of a competitive game trigger is to bestow the controller "moral authority" over the other party. In our experiments, the competitive game trigger was a dot game similar in nature to Hoffman and Spitzer's (1985b) game. The dot game is described in detail in the experiment instructions in Appendix C.[10]

After reading the instructions at least once and listening to the monitor read the instructions once, the subjects were given a set of questions designed to determine their understanding of the instructions. After the subjects correctly answered all questions and all relevant verbal questions were answered by the monitor, the controller was decided and the bargaining began. First, the subjects bargained over ex post rewards, then after switching bargaining partners the subjects bargained over ex ante lottery tickets.

After both the ex ante and ex post bargaining sessions were completed, the uncertainty about monetary payoffs was resolved. For the simple lottery game, the winner of the ex ante lottery was determined by a random draw of a lottery ticket from an urn. The composition of tickets corresponded to the contractual agreements made between the two parties. The winner received the entire large reward. In the ex post session, a random draw determined the winner, and the reward was distributed to the parties according to the contractual agreement.

In the compound lottery, uncertainty was resolved in two stages. First, the winner of the lottery was determined by random draw, then the amount of the reward, either R or r, was determined by a coin flip. The distribution of lottery tickets and the payoffs in the ex ante and ex post sessions correspond to the signed contractual agreements between the two parties.

4.4 Experimental Results

Table 4.2 presents the experimental results of Coasian bargaining under uncertain monetary payoffs. Proposition 1 P1 is supported: 86.6 percent (seventy-one out of eighty-two) of all bargains achieved a Pareto-efficient agreement. This results corresponds to the Coasian bargaining experiments under certainty. In a series of experiments, Hoffman and Spitzer (1982, 1985a, 1986) found that 89.5, 91, and 93 percent of bargains were efficient, and Harrison and McKee (1985) found 95.1 percent of all unilateral bargains were efficient. A simple t-test of two population proportions cannot reject the null hypothesis that the efficiency results in our experiments are not statistically different than the Harrison and McKee experiment with the highest efficiency (95.1%) with 95 percent confidence (t = -1.445). Consequently, our results support the weak behavioral form of Coasian bargaining even under uncertain payoff streams.

Proposition 2 P2 is not supported: 84.1 percent (sixty-nine out of eighty-two) of all bargaining agreements split the reward equally or within one dollar of the reward or ten percent of the

Table 4.2
Experimental Results

Experiment		Lottery	Schedule	N	Joint Maximum	Payoff Division: Equal Split	+/-10% +/-$1	Controller Earns Maximum	Controller Earns More Than Maximum	Disagreement	Other
Ex Ante											
	ASX	Simple	X	10	10	5	2	0	0	0	3
	ASY	Simple	Y	6	4	3	2	0	0	0	1
	ASZ	Simple	Z	7	6	5	1	0	0	0	1
	AS		ALL	23	20	13	5	0	0	0	5
	ACX	Compound	X	8	7	4	2	1	1	0	2
	ACY	Compound	Y	6	6	2	1	1	0	0	2
	ACZ	Compound	Z	4	3	2	1	1	0	0	0
	AC		ALL	18	16	8	4	3	1	0	2
Total (A)			AS+AC	41	36	21	9	3	1	0	7
Ex Post											
	PSX	Simple	X	6	5	4	1	1	0	0	0
	PSY	Simple	Y	10	8	8	2	0	0	0	0
	PSZ	Simple	Z	7	7	5	1	1	0	0	0
	PS		ALL	23	20	17	4	2	0	0	0
	PCX	Compound	X	6	4	6	0	0	0	0	0
	PCY	Compound	Y	8	7	6	2	0	0	0	0
	PCZ	Compound	Z	4	4	3	1	0	0	0	0
	PC		ALL	18	15	15	3	0	0	0	0
Total (P)			PS+PC	41	35	32	7	2	0	0	0
Grand Total			(A) + (P)	82	71	53	16	5	1	0	7

lottery tickets. Only in 7.3 percent (six out of eighty-two) of the agreements did the controller achieve or exceed the maximum expected reward attainable without bargaining. Clearly, the individuals did not follow a pattern of mutually advantageous bargaining. The subjects pooled their risks despite the experimental instructions explicitly stating the controllers "moral authority" over the bargaining session. Therefore, in contrast to Hoffman and Spitzer (1985a), the prebargain game trigger with moral authority is not sufficient to induce mutually advantageous bargaining given uncertain payoff streams.

Harrison and McKee (1985) argued that a small social surplus could create equal split bargaining. Social surplus is defined as the difference between the maximum joint chance to win (100%) and the next best alternative. We tested for this by using Schedule Z [Table 4.1] where the social surplus was 20% instead of 5% as in Schedules X and Y. In contrast to Harrison and McKee, the larger social surplus failed to induce mutually advantageous bargaining: 86.4% (nineteen out of twenty-two) of the bargains under Schedule Z were essentially an equal split. The results do not support the strong behavioral form of Coasian bargaining under uncertain monetary payoffs.

Proposition 3 P3 cannot be rejected given the results reported in Table 4.2. Using a Chi-square goodness-of-fit test [see Siegal (1956)] with a 90% confidence level, there is no statistical difference in bargaining over ex ante lottery and ex post rewards. Table 4.3 presents the results of the statistical

Table 4.3

Statistical Tests of Propositions 3 and 4

Test	Null Hypothesis	Chi-Square Test Statistic: Pareto Optimality	Equal Split
<u>Proposition 3</u>			
Ex Ante vs. Ex Post Bargaining			
	AS = PS[a]	0.025[b]	0.103
	AC = PC	0.000	0.833
	AS + AC = PS + PC	0.000	0.928
<u>Proposition 4</u>			
Simple vs. Compound Lottery			
	AS = A C	0.010[c]	0.066
	PS = PC	0.001	0.017
	AS + PS = AC + PC	0.006	0,003

[a] - Definition of variables is in Table 4.2

[b] - We cannot reject the null hypothesis for Proposition 3 with a 90% confidence level

[c] - We cannot reject the null hypothesis for Proposition 4 with a 90% confidence level

NOTE - See S. Siegal (1956) for an explanation of all statistical terminology.

tests. This result holds for both the weak (Pareto efficiency) and the strong (mutually advantageous bargains) behavioral firms of Coasian bargaining. The results also holds regardless of the lottery (simple or compound) or the social surplus (Schedule X and Y or Z).

This result implies no fundamental behavioral difference exists between bargaining over ex ante lotteries and ex post rewards. Individuals were just as likely to bargain efficiently and to split the lottery tickets or reward evenly. This result contrasts the valuation results of Chapter 2 in the experimental markets with one risk reduction mechanism. The valuation results indicated that individuals were willing to bid more for probability-influencing self-protection than severity-influencing self-insurance. The results of Coasian experiment fail to support this difference in behavior. Therefore, the observation of behavioral differences over probability and severity of an event may very well be experiment-specific and not readily transferable to a broader range of phenomena.

Proposition 4 P4 cannot be rejected given the statistical tests reported in Table 4.3. There appears to be no significant statistical differences in Coasian bargaining as risk increases. Both the bargainers in the simple and compound lottery were equally likely to be efficient and to pool risks to an essentially equal split of lottery tickets or rewards. Neither the simple or the compound lottery was sufficient to induce a change toward mutually advantageous bargaining. Risk pooling behavior was equally strong in both lotteries. The (non)robustness of Coasian bargain was found to be independent on the degree of uncertainty.

4.5 Conclusions

Coasian bargaining has been examined under uncertain payoff streams. Individuals bargained over both the ex ante probability of winning a reward (lottery tickets) and the ex post reward itself. The experimental results reported provided mixed support for the Coase theorem. The results strongly support the weak behavioral form of Coasian bargaining in that nearly 87% of all agreements were Pareto efficient. Unfortunately, the results do not support the strong behavioral form in that only 7.3% of agreements were mutually advantageous. Consequently, we must continue to support Hoffman and Spitzer's (1985b) warning about proposing policy recommendations based on the Coase theorem in natural occurring environments possessing any degree of uncertainty regarding monetary payoffs.

Finally, the results do not support the proposition that a fundamental difference exists in individual behavior toward ex ante lotteries (or probabilities) and ex post rewards (or severity). We find no behavioral difference in bargaining. Bargaining over both ex ante lotteries and ex post rewards are equally likely to generate Pareto efficient and nonmutually advantageous agreements.

ENDNOTES

1. Other studies include Harrison and McKee (1985), Harrison et al. (1987), Hoffman and Spitzer (1985a, 1986), and Coursey et al. (1987).

2. Harrison et al. (1986) note three other sources of bargaining breakdown not incorporated into the Coase theorem experiments. First, experimental contracts are perfectly enforced. Breach of contract was not an option to either of the two parties. Second, negotiation (or transaction) costs are assumed to be zero. Third, externalities were bilateral between the two bargaining parties. No third party was involved in either the damages or bargaining.

3. Even in the private or limited information experiments of Hoffman and Spitzer (1982) the payoff streams were deterministic.

4. Harrison et al. (1986) note "[o]f course, to be confident about these possibilities for bargaining breakdown we would have to promulagate a model involving uncertainty and test it. Natural environments are likely to include such uncertainties, so we again counsel caution in directly applying our results." [p. 400. Parantheses omitted].

5. See Ehrlich and Becker (1972), Marcel and Boyer (1983), Hiebert (1983), and Chang and Ehrlich (1985) for discussion of self-protection and self-insurance.

6. As in Harrison and McKee (1985), we consider an "essentially equal split" as being agreements with an equally split or a splot of +/- $1 of the reward or +/- 10 percent of the lottery tickets.

7. Also see Roth (1987) for a discussion on binary lottery games in economic experiments.

8. In our experiments, the Pareto-efficient outcome always implies $\overline{p}$ = p + (1-p) = 1. In other words, there is a 100 percent chance one of the two bargainers will win the large reward. This condition is not necessary, however, for Pareto-efficiency. For example, it could be that $\overline{p}$ = (p + (1-p) = .95 represents the Pareto efficient outcome. This would hold as long as 95% yielded the highest expected payoff for both parties. An interesting extension of these bargaining experiments would be to consider bargaining where the Pareto-efficient outcome is always less than 100%. This would provide a weak test of the generality of the so-called "certainty effect" discussed by Kahneman and Tversky (1979).

9. The "Winner's Curse" exists if a winner of a lottery or auction actually earns negative or less-than-expected profits when the monetary outcome of the lottery is revealed. See Thaler (1988).

10. See Nalebuff (1988) for another description of the dot game prebargain game trigger.

CHAPTER 5

Conclusions and Future Directions

Executive Order 12291 mandated all new major regulations be justified in terms of benefits and costs. Given the natural environment involves some degree of risk and uncertainty, benefit estimation has begun to concentrate on ex ante planned expenditures rather than ex post realized outcomes as the theoretical correct measure of welfare. The valuation technique currently advocated to measure ex ante planned expenditures is the controversial contingent valuation method. The contingent valuation method, however, is subject to a number of criticisms of uncontrollable biases. To combat these criticisms economists have turned to experimental economics. Laboratory experiments provide a structured, tightly-controlled environment with explicit structural incentives to control for real world noise. Experiments match individual behavior with theory, isolating potentially damaging biases before field implementation, thereby increasing the validity and accuracy of the contingent valuation method.

The purpose of this project is to examine the economic value of reduced risk in experimental markets. Three different experiments are designed to examine individual choice and behavioral outcomes under risk and uncertainty. The results provide insight into future avenues for exploration by practitioners of the contingent valuation method. First, the experiments provide evidence that the mechanism used to reduce risk is important. Reducing risk by altering the probability or severity of an undesirable event through a private or collective mechanism has induced significantly different value estimates. Future field contingent valuation experiments on reduced risk should consider the alternative routes to reduce risk. As noted earlier, the tradition focus has been on collective reductions of probabilities [e.g., Smith and Desvousges (1987)].

Second, value formation to a stable price occurred rapidly in experimental markets with one risk reduction mechanism. The rapid adjustment has two implications on contingent valuation: (1) the addition of a second-chance bid which allows the individual to adjust his or her initial bid after being provided with new market information may improve the accuracy of valuation response in a field context. New information such as average respondent valuation or outlay over an extended time horizon may induce the **tâtonnenent** process necessary for a stable implicit or explicit price. (2) The rapid bid adjustment indicated that learning does occur, thereby reducing fears of hypothetical asset bias raised by many critics of the contingent valuation approach. The learning, however, was not as robust in the more realistic experimental markets with two risk reduction mechanisms. The apparent tradeoff between learning in a repeated feedback framework is sensitive to the structure of risk reduction.

Third, if constraints force the elicitation of only one inexperienced hypothetical bid in field contingent valuation experiments, it may be the experienced bid can be predicted given prior information of value formation in experimental markets. The results indicate that the inexperienced bid is a significant predictor of the final experienced bid in both experimental markets with one and two mechanism. The initial inexperienced bid adjusted for learning could reflect the valuation of an asset in an experienced market. The robustness of this result, however, decreases in lotteries of 1% probability of an undesirable event occurring. This is not encouraging since most naturally-occurring environmental risks are generally less than 1% risk per year or lifetime.

Fourth, the results of the experimental markets with two risk reduction mechanisms indicate the necessity of including the option to respondents as to which mechanism, private or collective, they prefer. While noting that the subjective costs of participating may increase with a extra choice, the additional realism may provide a better mechanism for accurately revealing preferences for tradition non-market goods. The experimental markets could be structure individually or in actual groups as in the Brookshire and Coursey (1987) field experiments with a Smith-type auction process. Brookshire and Coursey, however, did not examine the substitutable private and collective framework in their field application of experimental insights into preference revelation.

Finally, there are numerous extensions to the basic experiment design in this report. One is to examine the experimental markets with two mechanisms under majority voting rules rather than unanimity voting rules. The goal would be to induce the private bidders to use their collective bid and not their veto power in determining if collective protection is purchased. Another extension would be to change the incentives for risk pooling in the bargaining experiments to examine if ex ante and ex post bargaining remains similar.

The most important extension, however, would be to examine valuation of reduced risk in experimental markets given temporal resolution of uncertainty. Timing of resolution of a risk and how it affects individual value formation has received little attention in the applied valuation literature. Typically, most environmental risks involve delayed (i.e., temporal) as opposed to immediately (i.e., timeless) resolved risk. For example, exposure to carcinogens often takes decades before the actual health effects are revealed. If temporal risk is the rule rather than the exception, then determining how delayed resolution affects value formation is important for understanding the economic value of reduced risk.

The results of the temporal experiments could prove useful to the EPA in two key ways. First, the experiments provide a detailed examination of individual choice and induced preference given temporal risk resolution. If, as theory predicts, individuals prefer timeless to temporal risk, one would expect a higher risk premium (i.e., more risk aversion) assigned to any temporal prospect. Such results would indicate that current timeless risk reduction valuations provide a lower bound on economic value. The temporal risk experiments will provide a test to determine if the timeless value estimates are downwardly biased.

Second, the timeless risk experiments present herein found that value formation occurred rather rapidly with repeated market trials. Bids for self-protection and self-insurance adjusted to a stable amount after just one or two additional market trials. These results are encouraging for the continuing use of demand revealing mechanisms such as the contingent valuation method since simple adjustments (e.g., "second-chance bid") can be made to the current one-shot field experiments. The experiments on temporal risk will provide a test of the robustness of rapid value formation given feedback is delayed. If value formation remains robust, then the addition of extra bidding trials in field experiments can generate a more accurate market response, even given delayed risk resolution. If value formation does not remain robust, however, one must then question whether repeated trials will add to accuracy in field contingent valuation experiments examining the economic value of reduced temporal risk.

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Appendix A

Instructions for Experimental Markets with One Risk Reduction Mechanism

S-P: Private self-protection market

S-I: Private self-insurance market

CoA: Collective self-protection market

CoASI: Collective self-insurance market

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? ______. There will be ten bidding trials in each probability period. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant is competing to purchase the right to protect him/herself from a certain probability of a $4 loss. The participant with the highest willingness to pay bid wins this right of protection and will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. The highest bidder _must in all cases_ pay the bid of the second highest bidder. All other participants are then subject to a random draw to determine if a loss or gain occurs. Note that in the event that there is a tie for the highest bid, those participants will be asked to rebid.

The actual experiment will proceed as follows:

Step 1: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

Step 2: The experimenter selects a probability period.

Step 3: Ten bidding trials will be run for the selected probability period.

Step 4: At the beginning of each bidding trial for a given probability period, you will state a bid by writing it on the recording card. Note that your initial income remains at $10 for each trial regardless of your winnings or losses in the trial periods before.

Step 5: After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of protection on the blackboard. The winner must pay the displayed price of protection.

Step 6: The experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone (except the highest bidder).

Step 7: After ten trial periods, a final hypothetical bid will be elicited for the probability period.

Step 8: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to insure against a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to fully insure against a 40% chance of losing $4 ______. There will be ten bidding trials in each probability period. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant is competing to purchase the right to insure him/herself from a certain probability of a $4 loss. The participant with the highest willingness to pay bid wins this right of insurance and will be guaranteed full coverage against potential $4 loss. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. All participants are subject to a random draw to determine if a loss or gain occurs. Note that in the event that there is a tie for the highest bid, those participants will be asked to rebid.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for insuring against a $4 loss in each of the four probability periods.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Ten bidding trials will be run for the selected probability period.

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will state a bid by writing it on the recording card. Note that your initial income remains at $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of insurance on the blackboard. The winner must pay the displayed price of insurance.

Step 6: The experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone (except the highest bidder).

Step 7: After ten trial periods, a final hypothetical bid will be elicited for the probability period.

Step 8: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of insurance.

Are there any questions?

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other Participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? ______. There will be ten bidding trials in each probability period. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant is cooperating to purchase the right to protect him/herself from a certain probability of a $4 loss. If the entire group's collective bids equal or exceed the cost of reducing the probability of a $4 to zero, then the group will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Ten bidding trials will be run for the selected probability period.

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will state a bid by writing it on the recording card. Note that your initial income remains at $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the sum of collective bids. If the bids exceed the costs then the experimenter will display the price of protection (average bid) on the blackboard.

Step 6: After the price is displayed each member votes on whether to purchase the protection. If each member votes "yes", then everyone must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain. However, if at least one member vetoes the purchase by voting "no", then everyone is subject to a random draw.

Step 7: If bids fail to exceed costs or if purchase of protection is vetoed, then the experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone.

Step 8: After ten trial periods, a final hypothetical bid will be elicited for the probability period.

Step 9: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

[CoASI]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to fully insure against a 40% chance of losing $4? ______. There will be ten bidding trials in each probability period. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant is competing to purchase the right to insure him/herself from a certain probability of a $4 loss. If the entire group's collective bids equal or exceed the cost of insuring against the probability of a $4 loss, then the group will be guaranteed full coverage. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Ten bidding trials will be run for the selected probability period.

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will state a bid by writing it on the recording card. Note that your initial income remains at $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the sum of collective bids. If the bids exceed the costs then the experimenter will display the price of insurance (average bid) on the blackboard.

<u>Step 6</u>: After the price is displayed each member votes on

whether to purchase the insurance. If each member votes "yes", then everyone must pay the displayed price of insurance, and is guaranteed full coverage against a potential $4 loss. However, if at least one member vetoes the purchase by voting "no", then everyone is subject to a random draw.

Step 7: If bids fail to exceed costs or if purchase of insurance is vetoed, then the experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone.

Step 8: After ten trial periods, a final hypothetical bid will be elicited for the probability period.

Step 9: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of insurance.

Are there any questions?

Appendix B

Instructions for Experimental Markets with Two Risk Reduction Mechanisms

SPCSP:	Private then collective self-protection
SICSI:	Private then collective self-insurance
CSPSP:	Collective then private self-protection
CSISI:	Collective then private self-insurance

[SPCSP]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment. The experiment is funded by the U.S. Environmental Protection Agency.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? ______. There will be five bidding trials in each probability period. Each bidding trial will elicit two bids: one competitive bid and one cooperative bid. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant will alternative between competitive and cooperative purchases of the right to protect him/herself from a certain probability of a $4 loss. First, for the cooperative bid, the participant with the highest willingness to pay bid wins the right of protection and will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. No random draw will be made after the competitive bidding. In the event there is a tie for the highest bid, those participants will be asked to rebid.

Second, for the collective bid, if the entire group's collective bids equal or exceed the cost of reducing the probability of a $4 to zero, then the group will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Ten bidding trials will be run for the selected probability period. Each bidding trial will elicit two bids, a competitive bid and a collective bid.

Step 4: At the beginning of each bidding trial for a given probability period, you will first state your competitive bid by writing it on the recording card. Note that your initial income returns at $10 for each trial regardless of your winnings or losses in the trial periods before.

Step 5: After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of protection on the blackboard. The winner must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain. No random draw will be made at this time.

Step 6: Next you will state your collective bid on a recording card. The winner of the competitive bid is not excluded from the competitive bidding process, and is required to enter a collective bid.

Step 7: After the recording card has been collected from each participant, the experimenter will display the sum of collective bids. If the bids exceed the costs then the experimenter will display the price of protection (average bid) on the blackboard.

Step 8: After the price is displayed each member votes on whether to purchase the protection. If each member votes "yes", then everyone must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain. However, if at least one member vetoes the purchase by voting "no", then everyone is subject to a random draw.

Step 9: If bids fail to exceed costs or if purchase of protection is vetoed, then the experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone except for the highest bidder of the competitive auction.

Step 10: After five trial periods, a final hypothetical bid will be elicited for the probability period.

Step 11: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

[SPCSP]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment. The experiment is funded by the U.S. Environmental Protection Agency.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? _______. There will be five bidding trials in each probability period. Each bidding trial will elicit two bids:

one competitive bid and one cooperative bid. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant will alternate between competitive and cooperative purchases of the right to protect him/herself from a certain probability of a $4 loss. First, for the cooperative bid, the participant with the highest willingness to pay bid wins the right of protection and will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. No random draw will be made after the competitive bidding. In the event there is a tie for the highest bid, those participants will be asked to rebid.

Second, for the collective bid, if the entire group's collective bids equal or exceed the cost of reducing the probability of a $4 to zero, then the group will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Five bidding trials will be run for the selected

probability period. Each bidding trial will elicit two bids, a competitive bid and a collective bid.

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will first state your competitive bid by writing it on the recording card. Note that your initial income returns to $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of protection on the blackboard. The winner must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain. No random draw will be made at this time.

<u>Step 6</u>: Next you will state your collective bid on a recording card. The winner of the competitive bid is <u>not</u> excluded from the competitive bidding process, and is required to enter a collective bid.

<u>Step 7</u>: After the recording card has been collected from each participant, the experimenter will display the sum of collective bids. If the bids exceed the costs then the experimenter will display the price of protection (average bid) on the blackboard.

<u>Step 8</u>: After the price is displayed each member votes on whether to purchase the protection. If each member votes "yes", then everyone must pay the displayed price of protection, and is guaranteed a 100% chance of a $1

gain. However, if at least one member vetoes the purchase by voting "no", then everyone is subject to a random draw.

<u>Step 9</u>: If bids fail to exceed costs or if purchase of protection is vetoed, then the experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone except for the highest bidder of the competitive auction.

<u>Step 10</u>: After five trial periods, a final hypothetical bid will be elicited for the probability period.

<u>Step 11</u>: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

[SPCSP]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment. The experiment is funded by the U.S. Environmental Protection Agency.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? ______. There will be five bidding trials in each probability period. Each bidding trial will elicit two bids:

one competitive bid and one cooperative bid. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant will alternate between competitive and cooperative purchases of the right to insure him/herself from a certain probability of a $4 loss. First, for the collective bid, the participant with the highest willingness to pay bid wins the right of insurance and will be guaranteed full coverage against a $4 loss. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. No random draw will be made after the competitive bidding. In the event there is a tie for the highest bid, those participants will be asked to rebid.

Second, for the collective bid, if the entire group's collective bids equal or exceed the cost of reducing the severity of a $4 to zero, then the group will be guaranteed full coverage against a chance of a $4 loss. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss to zero.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Five bidding trials will be run for the selected probability period. Each bidding trial will elicit two bids, a competitive bid and a collective bid.

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will first state your competitive bid by writing it on the recording card. Note that your initial income returns to $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of insurance on the blackboard. The winner must pay the displayed price of insurance, and is guaranteed full coverage. No random draw will be made at this time.

<u>Step 6</u>: Next you will state your collective bid on a recording card. The winner of the competitive bid is <u>not</u> excluded from the competitive bidding process, and is required to enter a collective bid.

<u>Step 7</u>: After the recording card has been collected from each participant, the experimenter will display the sum of collective bids. If the bids exceed the costs then the experimenter will display the price of insurance (average bid) on the blackboard.

<u>Step 8</u>: After the price is displayed each member votes on whether to purchase the insurance. If each member votes "yes", then everyone must pay the displayed price of insurance, and is guaranteed full coverage. However, if at least one member vetoes the purchase by voting "no", then everyone is subject to a random draw.

Step 9: If bids fail to exceed costs or if purchase of insurance is vetoed, then the experimenter will then draw one chip from the urn. A white chip results in a \$1 gain for everyone, a red chip results in a \$4 loss for everyone except for the highest bidder of the competitive auction.

Step 10: After five trial periods, a final hypothetical bid will be elicited for the probability period.

Step 11: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of insurance.

Are there any questions?

[CSPSP]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment. The experiment is funded by the U.S. Environmental Protection Agency.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to guarantee a 100% chance of winning $1 and a 0% chance of losing $4? ______. There will be five bidding trials in each probability period, Each bidding trial will elicit two bids:

one competitive bid and one cooperative bid. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant will alternate between competitive and cooperative purchases of the right to protect him/herself from a certain probability of a $4 loss. First, for the collective bid, if the entire group's collective bids equal or exceed the cost of reducing the probability of a $4 to zero, then the group will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. Each bidder <u>must in all cases</u> pay the bid of the collective. If the group's collective bids do not exceed the costs, then no protection is provided for the collective group.

Second, for the competitive bid, the participant with the highest willingness to pay bid wins the right of protection and will be guaranteed a 0% chance of a $4 loss and a 100% chance of a $1 gain. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. No random draw will be made after the competitive bidding. In the event there is a tie for the highest bid, those participants will be asked to rebid. Then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss.

<u>Step 2</u>: The experimenter selects a probability period.

<u>Step 3</u>: Five bidding trials will be run for the selected

probability period. Each bidding trial will elicit two bids, a collective bid and a competitive bid (if necessary).

<u>Step 4</u>: At the beginning of each bidding trial for a given probability period, you will first state your competitive bid by writing it on the recording card. Note that your initial income returns to $10 for each trial regardless of your winnings or losses in the trial periods before.

<u>Step 5</u>: After the recording card has been collected from each participant, the experimenter will display the sum of the collective bids. If the bids exceed the costs then the experimenter will display the price of protection (average bid) on the blackboard.

<u>Step 6</u>: After the price is displayed each member votes on whether to purchase the protection. If each member votes "yes", then everyone must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain. No random draw is necessary, and no competitive bid will be asked. We moved directly to the next bidding trial.

<u>Step 7</u>: However, if at least one member vetoes the purchase by voting "no", or if total bids fail to exceed costs, then no protection is purchased as a collective group. No random draw will be made at this time.

<u>Step 8</u>: If no protection is provided as a collective, then a competitive auction for protection will be run. You

are asked to state your competitive bid for protection by writing it on a recording card. After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of protection on the blackboard. The winner must pay the displayed price of protection, and is guaranteed a 100% chance of a $1 gain.

<u>Step 9</u>: After five trial periods, a final hypothetical bid will be elicited for the probability period.

<u>Step 10</u>: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

[CSISI]

Instructions

General

You are about to participate in an experiment about decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn money. You will be paid in cash at the end of the experiment. The experiment is funded by the U.S. Environmental Protection Agency.

Specific Instructions

You will be asked to make several decisions. Each decision will involve stating your maximum willingness to pay bid to eliminate a potential risk. <u>You are not to reveal your bid to any other participant. Note that any communication between bidders during a trial will result in an automatic loss of $4.</u>

Over the course of the experiment, you will be asked to bid your maximum willingness to pay to prevent a loss of $4 for a series of different probability periods (40%, 20%, 10%, and 1%). For example, given an initial starting income of $10, if there is a 60% chance that you will gain $1, and a 40% chance that you will lose $4, what is the maximum you would be willing to pay to fully insure against a 40% chance of losing $4? ______. There will be five bidding trials in each probability period. Each bidding trial will elicit two bids: one competitive bid and one cooperative bid. Note that for each trial the starting income will always be $10. Your gains or losses do not carry over to the next trial or probability period.

Each participant will alternate between collective and competitive purchases of the right to insure him/herself from a certain probability of a $4 loss. First, for the collective bid, if the entire group's collective bids equal or exceed the cost of reducing the probability of a $4 to zero, then the group will be guaranteed full coverage of a $4 to zero, then the group will be guaranteed full coverage against a chance of a $4 loss. Each bidder <u>must in all cases</u> pay the average bid of the collective. If the group's collective bids do not exceed the costs, then no insurance is provided for the collective group.

Second, for the competitive bid, the participant with the highest willingness to pay bid wins the right of insurance and will be guaranteed full coverage of a $4 loss. The highest bidder <u>must in all cases</u> pay the bid of the second highest bidder. No random draw will be made after the competitive bidding. In the event there is a tie for the highest bid, those participants will be asked to rebid. Then all participants are then subject to a random draw to determine if a loss or gain occurs.

The actual experiment will proceed as follows:

<u>Step 1</u>: At the beginning of the experiment you will state a separate hypothetical bid for reducing each of the four probabilities of a loss.

<u>Step 2</u>: The experimenter selects a probability period.

Step 3: Five bidding trials will be run for the selected probability period. Each bidding trial will elicit two bids, a collective bid and a competitive bid (if necessary).

Step 4: At the beginning of each bidding trial for a given probability period, you will first state your competitive bid by writing it on the recording card. Note that your initial income returns to $10 for each trial regardless of your winnings or losses in the trial periods before.

Step 5: After the recording card has been collected from each participant, the experimenter will display the sum of the collective bids. If the bids exceed the costs then the experimenter will display the price of protection (average bid) on the blackboard.

Step 6: After the price is displayed each member votes on whether to purchase the insurance. If each member votes "yes", then everyone must pay the displayed price of insurance, and is guaranteed full coverage. If insurance is purchased as a collective, we then skip Steps 7 and 8 and go to Step 9. A random draw is made at this point, and no competitive bid will be asked. We move directly to the next bidding trial.

Step 7: However, if at least one member vetoes the purchase by voting "no", or if total bids fail to exceed costs, then no insurance is purchased as a collective group. No random draw will be made at this time.

Step 8: If no insurance is provided as a collective, then a competitive auction for insurance will be run. You are asked to state your competitive bid for insurance by writing it on a recording card. After the recording card has been collected from each participant, the experimenter will display the winner (the highest bidder) and the price of insurance on the blackboard. The winner must pay the displayed price of insurance, and is guaranteed full coverage.

Step 9: At this time everyone is subject to a random draw. The experimenter will then draw one chip from the urn. A white chip results in a $1 gain for everyone, a red chip results in a $4 loss for everyone except for the highest bidder of the competitive bid.

Step 10: After five trial periods, a final hypothetical bid will be elicited for the probability period.

Step 11: The process will repeat until all four probability periods have been examined. Your take home income will consist of your initial income plus or minus your gains, losses, and purchases of protection.

Are there any questions?

Appendix C

Experimental Instructions for Coasian Bargaining over Ex Ante Lotteries and Ex Post Rewards

SIMP: Simple binary lottery experiment

COMP: Compound binary lottery experiment

EXPERIMENTAL INSTRUCTIONS

Introduction

You are about to participate in an experiment in decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn a considerable amount of money. You will be paid in cash at the end of the experiment.

General Instructions

You will be asked to make several choices over two sessions. Each choice will involve selecting a number. Each number represents a chance of earning a fixed monetary reward ($10). The chances of you earning the reward are given in the schedule

ten on the blackboard. For example, if 30 were next to

er 2 on the schedule (for the column pertaining to you), then

would have 30 out of 100 lottery tickets giving you a 30%

ce of earning the reward if number 2 were selected. The

dule lists the chance of you winning the reward as well as

chance of the other participant to win.

Two of you will participate together on each decision.

ough we will have two sessions, you will make only one

sion with any particular person. Each session will last ten

tes.

Agreement Outcome

You may arrive at two agreements with the other participant:
(1) Which number to choose, and depending on the session,
(2) How to allocate the resulting monetary reward,
or how to allocate the chances of winning the reward.
If a joint agreement is reached, both parties must sign the attached agreement form, stating both what the chosen number will be and how the reward or chances to win are to be transferred from one participant to the other. No physical threats are allowed. If a joint agreement is made and the form is signed, the monitor will terminate the session, determine which participant, if any, wins by drawing a chip from an urn, and pay each participant according to the terms set forth in the agreement.

Disagreement Outcomes

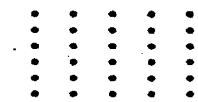
If you cannot come to an agreement before the end of each session both participants receive zero payoff for that session.

Controller

One of you will be designated the "controller" at the outset of each session. This will be decided using a dot game (explained below). The controller may, if he or she wishes, choose a number by himself or herself and inform the monitor, who will stop the experiment and determine the outcome of the session. The other participant may attempt to influence the controller to reach a mutually acceptable joint decision; the other participant may offer to give either part or all of his or her potential earnings or chances of winning (lottery tickets) to the controller depending on the session.

Dot Game

The goal of the dot game is to force your opponent to remove the last dot from the board.



If you accomplish this, then you will be the controller of a session. If you remove the last dot then the other individual is the controller.

The game is as follows:

1. Individuals alternate selecting a dot to be removed from the board. The individual who starts will be decided by a coin toss.
2. Once a dot is selected, the dot is removed along with all other dots located in a northeast direction. For example, if X was the dot selected the shaded region (below) represents all the additional dots to be removed.

3. The game continues until the last dot is removed.
4. The individual who removes the second to the last dot(s) has earned the right to be the controller. The controller has the final say over which number is selected

Example

The following example will be used to illustrate the decision in each session in which one participant is a controller.

Assume A is the controller and that participants A and B have the following number of lottery tickets reflecting their chances of winning the monetary reward with numbers 0, 1, 2:

Schedule (Example)

Number	A's Chance to Win (%)	B's Chance to Win (%)
0	20	70
1	55	40
2	80	20

Session 1

In Session 1 you and the other participant may arrive at two agreements:

(1) Which number to choose, and

(2) How to allocate the resulting reward.

Referring to the example schedule, first A and B agree to select a number. If A and B agree to set the number at 0, then A has 20 chances out of 100 (20%) to win, B has 70 chances out of 100 (70%) to win, and there are 10 chances out of 100 (10%) that. neither A nor B will win. If A and B agree to set the number at 2, then A has 80 chances out of 100 (80%) to win, B has 20 chances out of 100 (20%) to win, and there is 0 chance out of 100 (0%) neither A nor B will win. Suppose A and B agree to set the number at 2.

Second, A and B then agree how to allocate the $10 reward.

Suppose A and B agree that if B wins the reward, B will transfer $6 to A, or if A wins, A will transfer $4 to B, then regardless if A or B wins A gets $6 and B gets $4.

After both parties sign the agreement form, (example below) the monitor will determine the winner by drawing a lottery ticket (a chip) from the urn. Red chip--A wins, white chip--B wins, blue chip--neither A nor B wins. The composition of chips in the urn will correspond to the lottery tickets listed for the number selected. For example, since number 2 was selected the urn will contain 80 red chips, 20 white chips, and 0 blue chips. Say a red chip was drawn implying A wins, the monitor will then end the session and pay A $6 and pay B $4.

An illustrative agreement form is shown below.

Agreement Form 1 (Example)

A and B agree to set the number at ________.

A and B agree that if either A or B wins the reward then A will receive $________ and B will receive $_______.

Therefore, if A wins, A agrees to transfer $_______ to B,

or if B wins, B agrees to transfer $_______ to A.

Signed: A: ______________________________

B: ______________________________

Session 2

In Session 2 you and the other participant may arrive at two agreements:

(1) Which number to choose, and

(2) How to allocate the chances (lottery tickets) of winning the

reward.

Referring again to the example schedule, suppose A and B agree to set the number at 2, and further agree that B will transfer 10 lottery tickets to A. A now has 90 chances out of 100 (90%) to win, B has 10 chances out of 100 (10%) to win, and there is 0 chance out of 100 (0%) that neither A nor B will win.

The monitor will determine the winner by drawing a chip from the urn. The chips in the urn will correspond to the agreed on distribution of lottery tickets. Since number 2 was selected and A and B agreed that B would transfer 10 lottery tickets to A, the urn will contain 90 red chips, 10 white chips, and 0 blue chips. Recall, if a red chip is drawn--A wins; white chip--B wins; blue chip--neither A nor B wins. The winner of the draw will receive the full reward ($10).

Agreement Form 2 (Example)

A and B agree to set the number at ______.

A and B agree that ________ lottery tickets will be transferred from ________ to ________.

Signed: A: ______________________

B: ______________________

Do you have any questions? Please answer the following questions to make sure that you understand the instructions.

Questions

(Refer to the payoffs marked EXAMPLE on the blackboard.)

1. Number _______ gives me the highest chance to win.
   Number _______ gives me the lowest chance to win.
2. If the other participant is the controller and he picks number 4, I have _______ chances out of _______ to win.
3. If I am the controller and I select number 3, there are _______ chances out of _______ that neither party will win.
4. Referring to Session 1, if I agree to earn $2 regardless of who (A or B) wins and we agree on number 1: (a) I have _____ chances out of _______ to earn the $2: (b) I have _______ chances out of _______ not to earn $2.
5. Referring to Session 2, if we agree to select number 2 and I agree to transfer 10 lottery tickets to the other participant: (a) I have _______ chances out of _______ to earn $10; (b) I have _______ chances out of _______ not to earn $10.

[COMP]

EXPERIMENTAL INSTRUCTIONS

Introduction

You are about to participate in an experiment in decision making under risk and uncertainty. The purpose of the experiment is to gain insight into certain features of economic processes. If you follow the instructions carefully you can earn a considerable amount of money. You will be paid in cash at the end of the experiment.

General Instructions

You will be asked to make several choices over two sessions. Each choice will involve selecting a number. Each number represents a chance of winning the first stage of a two-stage lottery. The chances of you winning the first stage of the lottery are given in the schedule written on the blackboard. For example, if 30 were next to number 2 on the schedule (for the column pertaining to you), then you would have 30 out of 100 lottery tickets giving you a 30% chance of winning the first stage if number 2 were selected. The schedule lists the chance of you winning the first stage as well as the chance of the other participant to win.

The winner of the first stage then moves into the second stage and has a chance of winning a monetary reward. The amount of the reward ($10 or $0) is determined at random. There is an equal chance (50%) of earning $10 or earning $0.

Two of you will participate together on each decision. Although we will have two sessions, you will make only one decision with any particular person. Each session will last ten minutes.

Agreement Outcome

In the first stage of the lottery you may arrive at two agreements with the other participant:

(1) Which number to choose, and depending on the session,

(2) How to allocate the resulting monetary reward, or how to allocate the chances of winning the first stage of the lottery.

If a joint agreement is reached, <u>both</u> parties must sign the attached agreement form, stating both what the chosen number will be and how the reward or chances to win are to be transferred from one participant to the other. <u>No physical threats are allowed</u>. If a joint agreement is made and the form is signed, the monitor will terminate the session. The monitor will determine which participant, if any, wins the first stage by drawing a chip from an urn. The amount of the monetary reward ($10 or $0) will then be determined at random in the second stage of the lottery. Each potential reward has an equal chance (50%) of being selected. The monitor will pay each participant according to the terms set forth in the agreement.

Disagreement Outcomes

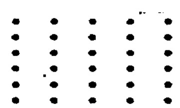
If you cannot come to an agreement before the end of each session both participants receive zero payoff for that session.

Controller

One of you will be designated the "controller" at the outset of each session. This will be decided using a dot game (explained below). The controller may, if he or she wishes, choose a number by himself or herself and inform the monitor, who will stop the experiment and determine the outcome of the session. The other participant may attempt to influence the controller to reach a mutually acceptable joint decision; the other participant may offer to give either part or all of his or her potential earnings or chances of winning the first stage (lottery tickets) to the controller depending on the session.

Dot Game

The goal of the dot game is to force your opponent to remove the last dot from the board.



If you accomplish this, then you will be the controller of a session. If you remove the last dot then the other individual is the controller.

The game is as follows:

1. Individuals alternate selecting a dot to be removed from the board. The individual who starts will be decided by a coin togs.
2. Once a dot is selected, the dot is removed along with all other dots located in a northeast direction. For example, if X was the dot selected the shaded region (below)

represents all the additional dots to be removed.

3. The game continues until the last dot is removed.

4. The individual who removes the second to the last dot(s) has earned the right to be the controller. The controller has the final say over which number is selected, and may select a number at any time and inform the monitor to end the session.

Example

The following example will be used to illustrate the decision in each session in which one participant is a controller.

Assume A is the controller and that participants A and B have the following number of lottery tickets reflecting their chances of winning an uncertain monetary reward with numbers 0, 1, 2:

Schedule (Example)

Number	A's Chance to Win (%)	B's Chance to Win (%)
0	20	70
1	55	40
2	80	20

Session 1

In Session 1 you and the other participant may arrive at two agreements:

(1) Which number to choose, and

(2) How to allocate the resulting reward.

Referring to the example schedule, first A and B agree to select a number. If A and B agree to set the number at 0, then A has 20 chances out of 100 (20%) to win the first stage, B has 70 chances out of 100 (70%) to win the first stage, and there are 10 chances out of 100 (10%) that neither A nor B will win the first stage. If A and B agree to set the number at 2, then A has 80 chances out of 100 (80%) to win, B has 20 chances out of 100 (20%) to win, and there is 0 chance out of 100 (0%) neither A nor B will win the first stage. Suppose A and B agree to set the number at 2.

Second, A and B then agree how to allocate the uncertain reward to be determined in the second stage of the lottery. There is an equal chance (50%) the reward will be $10 or $0. The reward will be determined by a coin flip by the monitor. Suppose A and B agree that if B wins the reward, B will transfer 60% of the reward to A, or if A wins, A will transfer 40% of the reward to B, then regardless if A or B wins A gets 60% and B gets 40% of the realized reward.

After both parties sign the agreement form, (example below) the monitor will determine the winner of the first stage by drawing a lottery ticket (a chip) from the urn. Red chip--A wins, white chip--B wins, blue chip--neither A nor B wins. The composition of chips in the urn will correspond to the lottery tickets listed for the number selected. For example, since number 2 was selected the urn will contain 80 red chips, 20 white chips, and 0 blue chips. Say a red chip was drawn implying A wins. The reward will then be randomly determined by the monitor in the second stage of the lottery. Suppose the realized reward was $10. The monitor will then end the session and pay A 60% ($6) and pay B 40% ($4) of the realized reward.

An illustrative agreement form is shown below.

Agreement Form 1 (Example)

A and B agree to set the number at ________.

A and B agree that if either A or B wins the reward then A will **receive ______% and B will receive ______% of the reward.**

Therefore, if A wins, A agrees to transfer ______% of the reward to B,

or if B wins, B agrees to transfer ______% of the reward to A.

Signed: A: ________________________

B: ________________________

Session 2

In Session 2 you and the other participant may arrive at two agreements:

(1) Which number to choose, and

(2) How to allocate the chances (lottery tickets) of winning the first stage of the lottery.

Referring again to the example schedule, suppose A and B agree to set the number at 2, and further agree that B will transfer 10 lottery tickets to A. A now has 90 chances out of 100 (90%) to win the first stage, B has 10 chances out of 100 (10%) to win the first stage, and there is 0 chance out of 100

(0%) that neither A nor B will win the first stage.

The monitor will determine the winner of the first stage by drawing a chip from the urn. The chips in the urn will correspond to the agreed on distribution of lottery tickets Since number 2 was selected and A and B agreed that B would transfer 10 lottery tickets to A, the urn will contain 90 red chips, 10 white chips, and 0 blue chips. Recall, if a red chip is drawn--A wins; white chip--B wins; blue chip--neither A nor B wins. The winner of the draw will receive the full reward, either $10 or $0 which will be determined by a coin flip in the second stage of the lottery.

Agreement Form 2 (Example)

A and B agree to set the number at ______.

A and B agree that ________ lottery tickets will be transferred from _______ to _______.

Signed: A: ____________________

B: ____________________

Do you have any questions? Please answer the following questions to make sure that you understand the instructions.

Questions

(Refer to the payoffs marked EXAMPLE on the blackboard.)

1. Number _______ gives me the highest chance to win the first stage of the lottery.

   Number _______ gives me the lowest chance to win the first stage.

2. If the other participant is the controller and he picks number 4, I have _______ chances out of _______ to win the first stage.

3. If I am the controller and I select number 3, there are _______ chances out of _______ that neither party will win the first stage.

4. Given the winner of the first stage has been determined, there is a _______% chance that the realized reward will be $0. There is a _______% chance that the realized reward will be $10.

5. Referring to Session 1, if I agree to earn 20% of the realized reward ($10 or $0) regardless of who (A or B) wins and we agree on number 1: (a) I have ______chances out of _________ to earn the 20% of the realized reward: (b) I have ______ chances out of _______ not to earn 20% of the realized reward.

6. Referring to Session 2, if we agree to select number 2 and I agree to transfer 10 lottery tickets to the other

participant: (a) I have _______ chances out of _______ to win the first stage of the lottery; (b) I have _______ chances out of ________ not to earn win the first stage.